Southeast Fisheries Science Center
Standard Operating Protocols for
Shrimp Trawl surveys

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center

Table of Contents

Introduction

Recent Data Collection

The modern era of fisheries research in the Gulf began when the OREGON II commenced operations in late 1967. However, for the first five years of OREGON II operations, as in the earlier cruises, sampling was primarily exploratory in nature and little quantitative information can be obtained from these records. Methods of collecting fisheries resource data changed significantly in the early 1970's. These changes reflected a growing awareness of the need to quantify data for purposes of managing fisheries. The Magnuson Fishery Conservation and Management Act of 1976 provided further impetus for a quantitative approach to management of fisheries resources.

The adoption in 1972 of a stratified random sampling design for groundfish surveys marked the beginning of current sampling strategy. Although revisions and improvements to the original sampling scheme have occurred over the years, this long-term quantitative and qualitative data base lends itself well to assessment of changes in species composition, abundance and distribution over time. All groundfish and shrimp data collected since 1972 have been entered in computers and are available to the research community upon request.

SEAMAP – Sampling design and standardized data collection procedures

Cruises in support of the Texas shrimp closure began in June 1981, and came under the Southeast Area Monitoring and Assessment Program (SEAMAP) beginning in 1982. The sampling design for these cruises was somewhat different from the traditional groundfish protocol. Details of this design are given by Nichols in "Derivation of Red Snapper Time Series from SEAMAP and Groundfish Trawl Surveys" available at,
http://www.sefsc.noaa.gov/sedar/download/SEDAR7_DW1.pdf?id=DOCUMENT1982
The sampling area now extends from the US/Mexican border to the Florida Keys. While most of the sampling effort using trawls has been in the 5-60 fm depth range, another set of cruises designed to map the distribution and abundance of small pelagic fishes operates in the depth range of 20 to 300 fm, with the majority of effort in the 20-200 fm range.

Initially trawling was only conducted at night during SEAMAP cruises, due primarily to the nocturnal behavior of certain shrimp species. Beginning in 1987, day and night sampling of an equal number of stations was instituted. This sampling design was also extended to groundfish cruises as well. The current sampling design which began in Fall 2008 consists of random sampling with proportional allocation according to surface area. Shrimp statistical reporting zones and two depth ranges (5-20 and 20-60 fms) were used as allocation units in order to minimize gaps and clumping of sampling sites.

At each trawl station, standardized sampling procedures are employed. At the culmination of each tow, the catch is brought aboard and weighed. If the total weight of the catch is greater than 22.7 kg (50 lbs.), the catch is sub sampled. Catches smaller than 22.7 kg are worked up in their entirety. The only exception to this rule is in situations where very high species diversity exists. Under such circumstances, the watch leader may exercise the option of sub sampling a catch of less than 22.7 kg. The entire catch or sub sample is sorted to the lowest possible taxon, counted, weighed, measured and sexed where possible. Sexing individuals is frequently dependent on the size of the individual.

Collection of length frequency data began as a part of the groundfish cruises where it has long been policy to measure a sample of the sciaenids. Beginning in 1987, this practice was changed to require measurement of all species captured on all cruises. During the June-July and October-November cruises, measurements have been taken of over 40,000 specimens per cruise.

Sporadically before, but regularly beginning about 1981, environmental data including temperature, salinity, chlorophyll and dissolved oxygen have been collected at all stations where a biological sample is taken. For those cruises that fall under the auspices of SEAMAP an atlas of biological and environmental data is published annually. SEAMAP atlases now cover data from 1982 to present.

During the years there have been a number of special studies in which trawls were used. In most, data were collected in a manner similar to that employed during standardized trawl surveys. These studies have included shrimp bycatch aboard commercial shrimp fishing vessels, studies of turtle excluder devices (TEDs) in which one net was a standard net while the other was equipped with a turtle excluder, studies of bycatch reduction devices (BRDs) using a standard net versus a net with a BRD, and so on. These data sets, while limited in duration, can often be used to complement the longer term data sets especially if spatial coverage coincides. Also, these special studies are often conducted aboard commercial trawlers thus providing fishery-dependent indices of species composition and abundance for comparison with fishery-independent resource surveys information.

Protocol 1: Length measurement of trawl warp

NOAA Protocol 1 for shrimp trawl surveys requires two independently calibrated measuring methods or devices for each trawl warp. The SEFSC summer and fall shrimp surveys will use physical marking of the warps by spooling the wires off the drums and onto a flat surface where wires are marked side-by-side, as the first measure. The second measure used by SEFSC will be wire meters on the warp. Calibration of the in-line wire meters will occur during annual maintenance. At least once per year, the meter blocks will be returned to the manufacturer where broken and worn parts will be replaced and the units cleaned and lubricated.

Since the SEFSC uses a single warp and bridle system, side-by-side comparisons of warps are not as critical as with two warp systems. Stretching or other changes in measurements of the warp can affect the warp angle and scope, but not the configuration of the net. Thus, even extensive stretching of the warp is not expected to have much influence on the efficiency of the net.

Protocol 2: Survey operational procedures

Since the inception of SEAMAP in the early 1980's, the SEFSC has maintained a SEAMAP Operational Manual describing the procedures and gear used in all surveys. This document is constantly being updated as changes in procedures and new technological advances are introduced into the at-sea sampling. The manual includes information regarding the objectives of the survey, the survey design, and the detailed procedures that should be followed at every station. Some of the more obvious issues addressed in the operational plan are listed below, but the full plan attempts to address these and other contingencies that may affect the sampling efficiency of the survey. Survey gear is either manufactured by professional net makers or constructed by Mississippi Laboratory personnel. In both cases, nets are inspected by Harvesting Unit members using a standard inspection sheet to verify that nets meet design specifications. Nets are rigged by research vessel personnel under the supervision of Harvesting Unit members to assure that otter boards are properly set, the tickler chain is the correct length, and bridle length is appropriate. Once assembled, the gear remains in use until fouled by bottom obstructions, at which time it is replaced. Only very minor net repairs are conducted at sea.

Sub-protocol 2a: Scope Ratio

Scope ratio varies according to sampling depth and is provided to bridge officers in the following table. Chief Scientists discuss this table with vessel Captains to ensure that guidelines are adhered to. In some cases these ratios may be altered due to currents or adverse weather conditions.

Water Depth (fathoms)	Scope Ratio	Warp (fathoms)	Water Depth (fathoms)	Scope Ratio	Warp (fathoms)
5	7.0	35	29	4.1	118
6	5.8	35	30	4.0	120
7	5.0	35	31	4.0	124
8	5.0	40	32	4.0	128
9	5.0	45	33	4.0	132
10	5.0	50	34	4.0	136
11	5.0	55	35	4.0	140
12	5.0	60	36	4.0	144

13	5.0	65	37	4.0	148
14	5.0	70	38	4.0	152
15	5.0	75	39	4.0	156
16	5.0	80	40	4.0	160
17	5.0	85	41	4.0	164
18	5.0	90	42	4.0	168
19	5.0	95	43	4.0	172
20	5.0	100	44	4.0	176
21	4.9	102	45	4.0	180
22	4.7	104	46	4.0	184
23	4.6	106	47	4.0	188
24	4.5	108	48	4.0	192
25	4.4	110	49	4.0	196
26	4.3	112	50	4.0	200
27	4.2	114	60	4.0	240
28	4.1	116			

Sub-protocol 2b: Speed of tow

Targeted towing speed is 4.6 kilometers hour^{-1} (2.5 knots) and is determined by the bridge officer considering the speed over ground provided by GPS and Doppler Speed Log. Towing speed is recorded every 5 seconds throughout the tow by the ship's Scientific Computing System, and an average speed calculated at the end of the tow. Four different sensors monitor speed, and any one, or combination of sensors, can be used to calculate speed of the vessel over the course of a tow. Interestingly, each of the sensors give slightly different readings, and we are continuing to compare these sensors to determine which one, or combination, should be used as the standard. Fortunately with SCS, data from all sensors and cruises can be recovered when a standard has been selected.

Sub-protocol 2c: Tow Duration

Shrimp/Bottomfish survey trawl tows are 30 minutes in duration. Start of tow occurs when the winch operator dogs the winch (pay-out ceases and the brake is set). End of tow occurs when the winch brake is released and haul back begins. Reduction of tow duration shall be avoided and only done after consultation with the Chief Scientist. At no time will tows exceed 55 minutes in observance of marine turtle conservation requirements.

Sub-protocol 2d: Direction of tow

Tow direction is generally at the discretion of the Officer of the Deck (OOD) based on knowledge and experience of the sampling location, and local traffic. Direction is often on course to the next station in order to optimize available survey time. On occasions the Watch Leader or Chief Scientist may request the OOD to tow in following seas during rough weather to facilitate processing of catches.

Sub-protocol 2e: Location of sampling sites, and procedures to use if station is untrawlable

Sampling sites are selected randomly with two restrictions placed on randomization, shrimp statistical reporting zones and depth (5-20fms and 20-60fms). Approximately two weeks prior to departure, the Chief Scientist provides the Operations Officer data files which contain the locations of the randomly selected stations. These files are format compliant for direct import into the ships navigation software.

Upon arrival at station locations, two sources are used to anticipate bad bottom, consultation of historical hang data (locations where nets were torn on previous surveys) and inspection of bottom information provided on navigational charts. When there is concern over untrawlable bottom, the sampling location is surveyed and the bottom is inspected for relief or obstructions using the ship's SIMRAD EQ50 color scope fathometer. A joint decision is then made by the Chief Scientist or Watch Leader, and OOD. In cases where high relief or obstructions are detected, the vessel moves in the direction of the next station while surveying the bottom. When trawlable bottom is located, the tow is conducted. If suitable bottom is not detected before reaching the next station, the original station is dropped.

Sub-protocol 2f: Criteria for determining the success of a tow and procedures to use if a tow was unsuccessful

A tow is deemed successful if established protocols were followed throughout the tow, and there were no indications of damage or fouling of the net, doors or tickler chain. Catch magnitude provides insight to tow acceptability during the Fall Survey, however this technique cannot be used during the Summer Survey due to hypoxic conditions in the northcentral Gulf where water hauls are common. If the tow is deemed unsuccessful due to known causes and the gear remains undamaged, the tow is repeated. If the gear is damaged over the course of a tow, the station is dropped.

Sub-protocol 2g: Vessel and winch operation during trawl deployment and retrieval

Vessel speed while setting the net is about 9.2 km hr^{-1} (5 kts). The winch operator informs the bridge when about 20 fms of towing warp remains to be deployed, and the OOD adjusts the throttle and pitch to achieve the towing speed of 4.6 km hr^{-1} (2.5 kts). Towing speed is maintained during haul-back with no pulsing as is commonly done with larger nets sampling pelagic species.

Sub-protocol 2h: Length measurement of trawl warps

Towing warp is measured by two techniques, marking the cable at known length intervals (25 fms apart) and block wire counters. Wire counters are calibrated during each tow by verifying the length of a 30-fm towing bridle. The effects of wire stretching with a single warp bridle system would be a change in the warp angle but not the configuration of the net. Thus, stretching of one or two fathoms is believed to have little or no effect on sampling efficiency. Warps are marked prior to the cruise as part of the OMAO measurement process.

Sub-protocol 2i: Trawl construction plans, at-sea repair instructions and repair verification check-list

Trawl construction plans are attached. At-sea repairs are limited to sewing minor tears in the nets. If significant damage is noted, the nets are replaced. Minor gear damage (torn webbing of less than a meter area) is repaired by the ship's Deck Department with the Chief Scientists approval. If damage to a net is extensive (more than a meter or in multiple locations), repairs are not attempted and the net is replaced.

Sub-protocol 2j: Defining responsibility (i.e. survey scientists or vessel crew) for decisions regarding various aspects of the operation

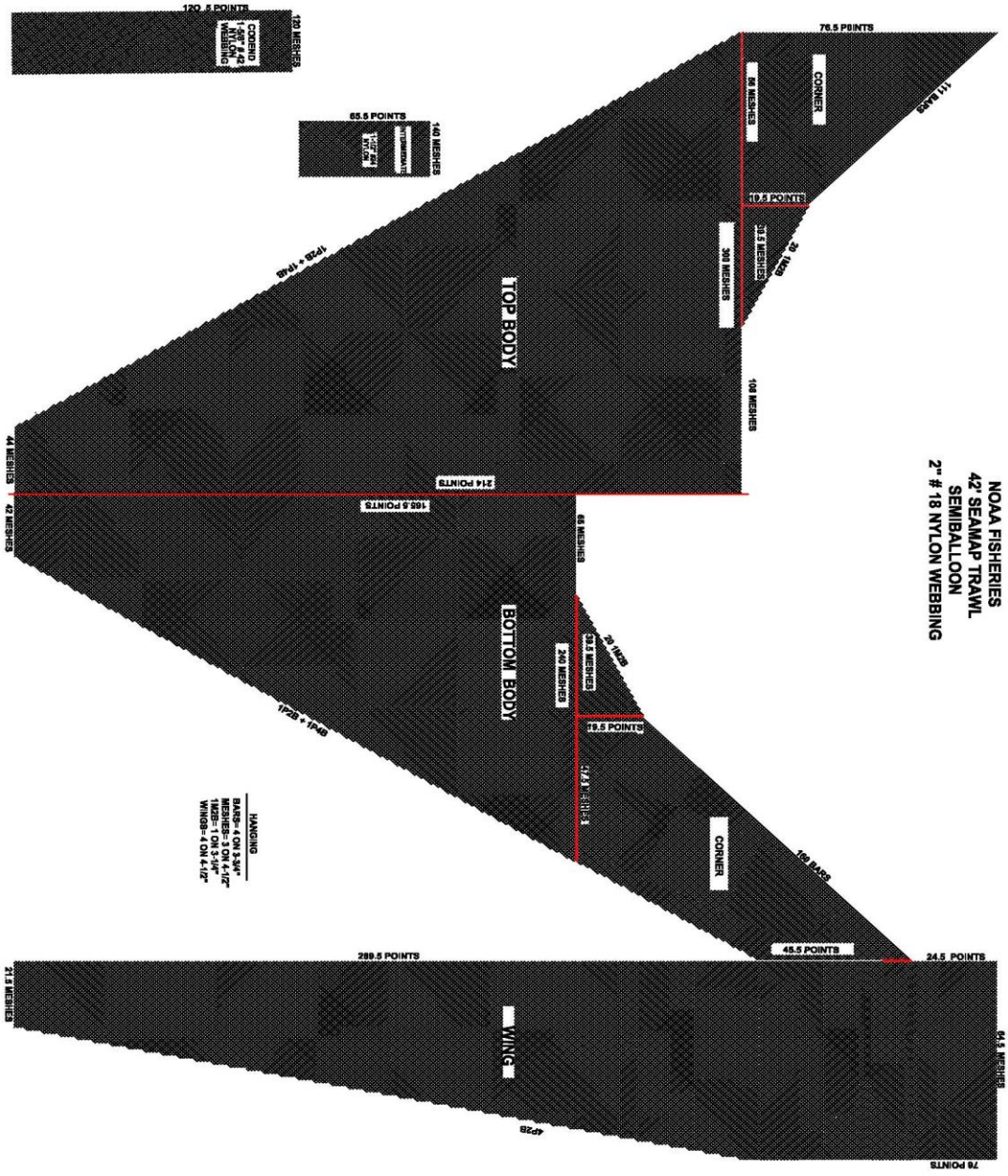
The Captain of the vessel has ultimate responsibility for the safety of the ship, crew and scientific party. Safety is always top priority. The Captain shall conduct field operations in a manner consistent with the safe navigation of the vessel, and work closely with the Chief Scientist to

determine the most efficient track lines. Only the Chief Scientist may cancel stations, change mission priorities, direct the activities of the scientific party and relocate stations more than 1.0 nautical miles from original locations. The Chief Scientist may not direct or interfere with the work of the ship's crew.

Protocol 3: Trawl construction and repair.

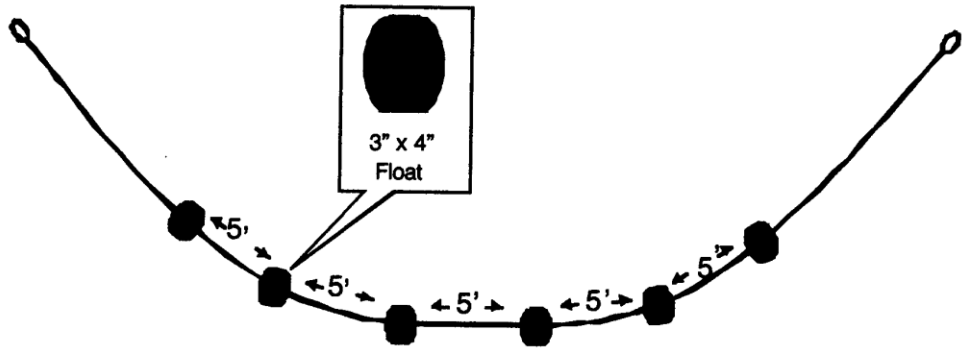
The trawl used in the SEFSC for shrimp and groundfish surveys is a 42-foot semi-balloon shrimp trawl. This trawl has been the standard employed for surveys since the early 1970s. The SEFSC trawls are constructed in-house by FMES gear specialists, and rigorous quality control measures are used to ensure uniformity of materials and construction measurements. With the exception of minor on-board repairs, nets are replaced by new nets when gear is retrieved and found to be damaged. A detailed description of the nets and construction procedures is provided below.

42-ft SEAMAP trawl - diagram and specifications

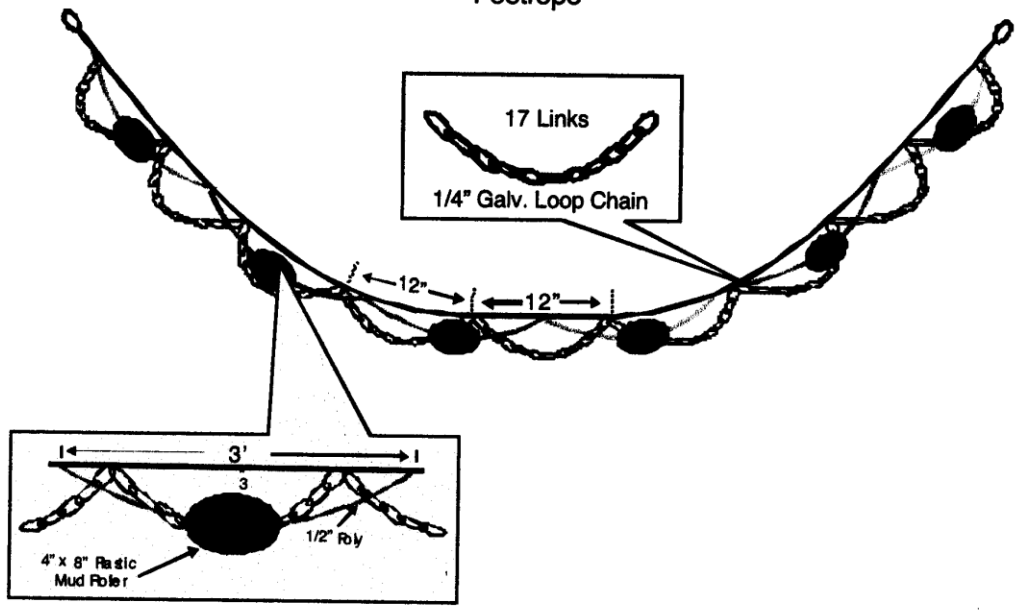


42' SEAMAP Trawl

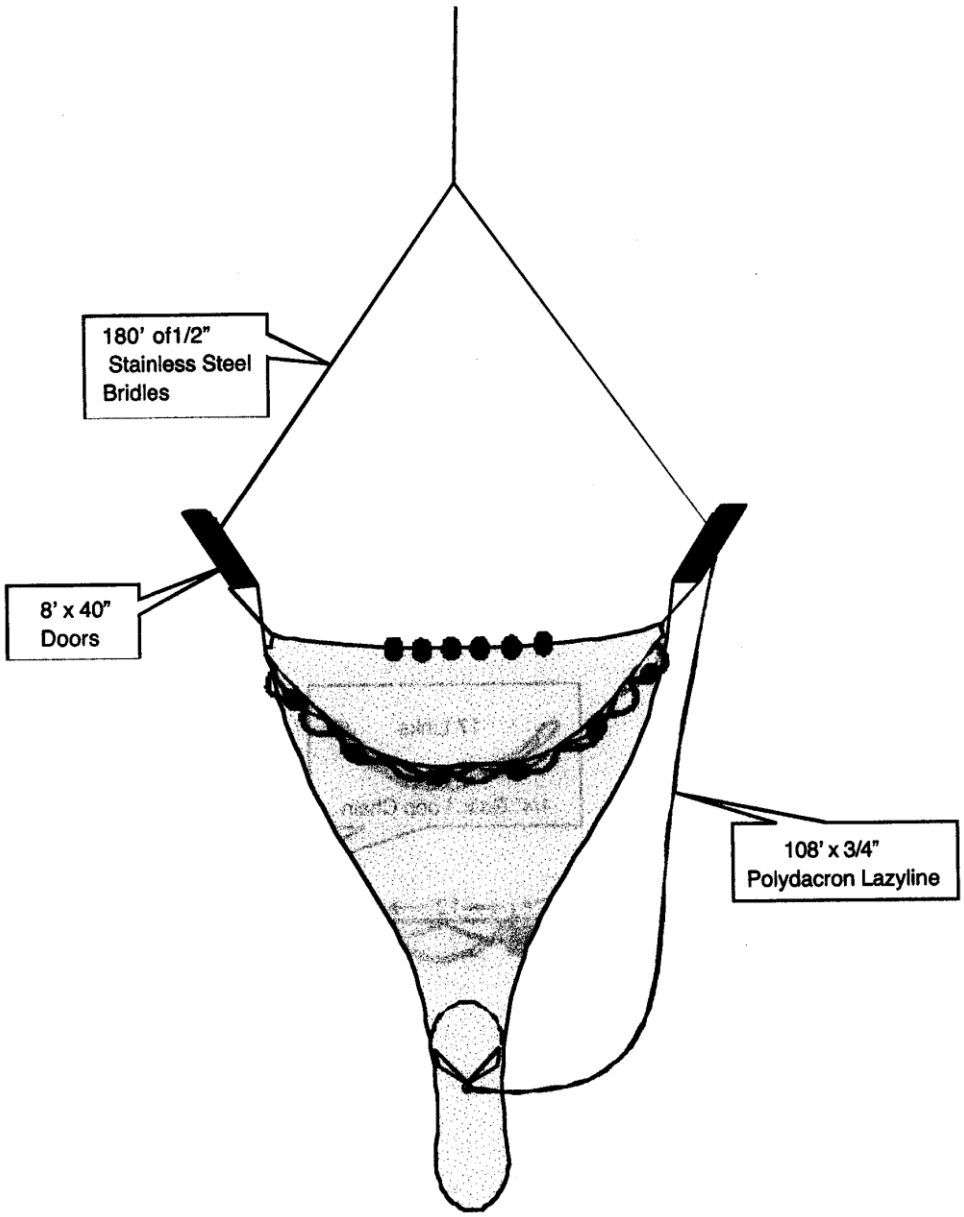
Headrope



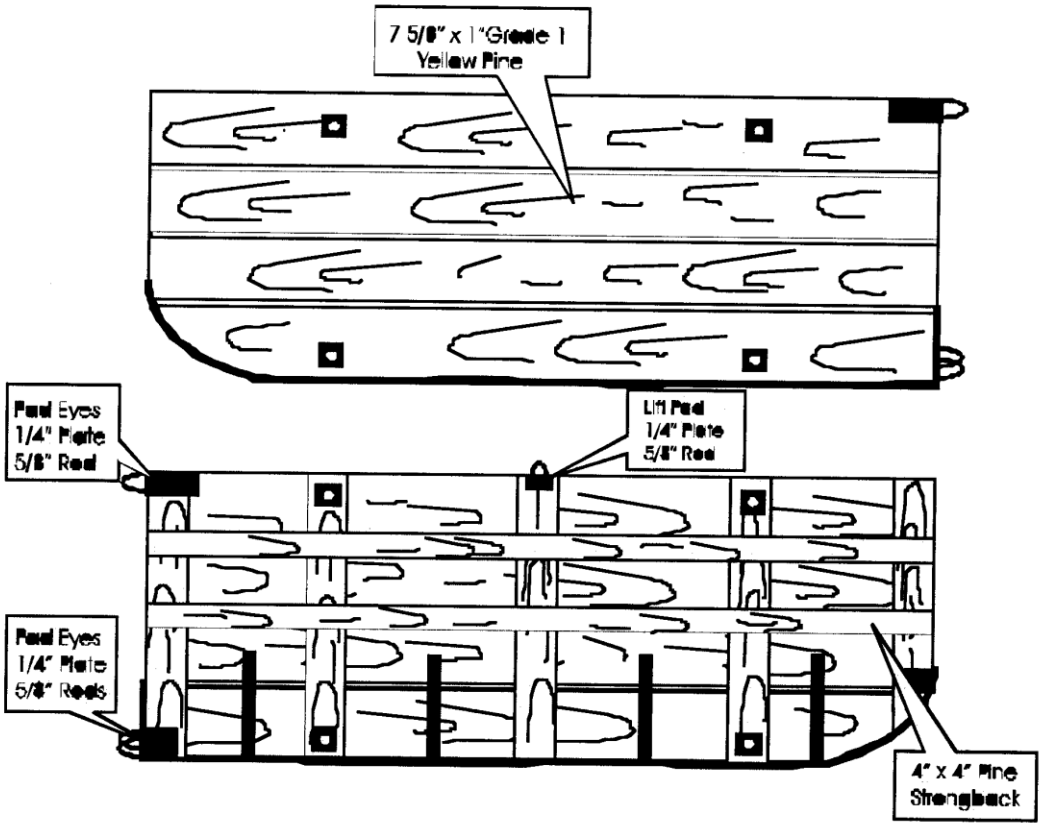
Footrope

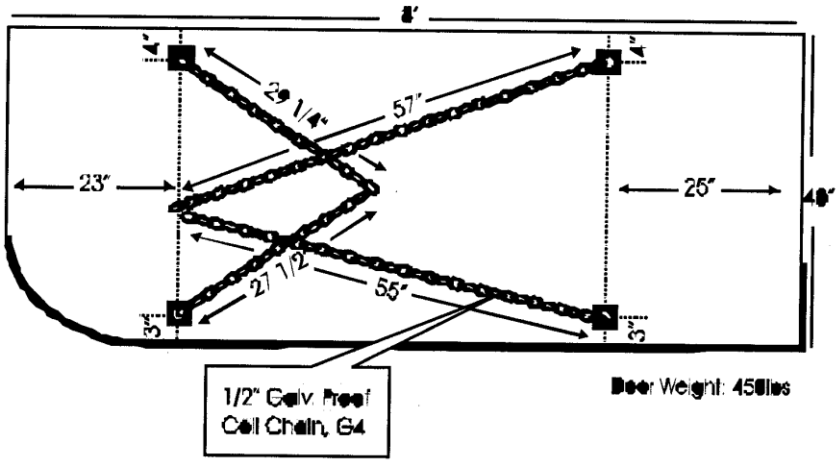


42ft SEAMAP Trawl



8' x 48" Rectangular Flat Doors





Trawl Specifications

1) Webbing – Twisted nylon:
   a) Body, wings, corners, and jibs – 2″ stretched mesh, number 18 nylon twine.
   b) Intermediate – 1½″ stretched mesh, number 24 nylon twine.
   c) Cod end – 1⅝″ stretched mesh, number 42 nylon twine.
   d) Twine area – 240.27 ft^2.
2) Hanging Cable:
   a) Headrope and footrope – 9/16″ diameter (6x6) polyethylene covered stainless steel combination net rope.
   b) Leglines – 6 feet with heavy duty wire rope thimbles.
   c) Wing lines – ⅜″ polydacron three-strand rope.
3) Weight
   a) Loop chain – 50 loops of ¼″ galvanized standard link, 16 links per loop, tied every foot. Weight-48 lbs.
4) Mud Rollers
   a) 17, 4″ by 8″ mud rollers on a separate ½″ polypropylene line tied every 3', with 3″ of slack between the top of the roller and the bottom of the footrope.
5) Flotation
   a) Six 3″ by 4″ spongex floats spaced 5 feet across the center of the headrope and 5 feet apart.
6) Lazyline
   a) 18 fathoms of ¾″ polydacron three-strand rope
7) Net Treatment
   a) Green plastic net coat
8) Door Specifications
   a) Door Type – Rectangular flat wooden otter boards
   b) Length and Height– 8' long by 40″ high
   c) Chains – ½″ proof coil chain (Note: ½″ proof coil test 9,000lb @ $1.83/ft will stretch, ⅜″ grade 40 test 8,900lb @ $1.17/ft does not stretch easily. Price difference of $18.81)
   d) Swivels – ⅝″ galvanized
   e) Bolts – 5/16″ cadmium plated
   f) Planking – 5/4″ yellow pine, Grade 1
   g) Stiffeners – 4″ x 4″ yellow pine
   h) Uprights – 2″ x 10″ yellow pine
   i) Shoe – 1″ x 6″ flat stock
   j) Doors have 23½″ chain bracket (tow point to door face)
   k) Door Surface Area – 53.2 ft^2 per set
   l) Door weight – 450 lbs
9) Tickler Chain Specifications
   a) Type – Standard free tickler
   b) Size – ¼″ standard link galvanized proof coil chain
   c) Length – 42″ shorter than the footrope including the leglines (about 58.6')
   d) Weight – 4l.6 lbs
10) Bridle Specifications
   a) Type – Split bridle, single warp
   b) Wire Type – 6 by 19 strand galvanized IWRC wire rope
   c) Wire Diameter – ½″

d) Length/Leg – 30 fms or 180'

SEAMAP Trawl Checklist

Inspector: _____ Date: _____ Trawl No.: _____

Description/Tolerance	Measurement
A. Webbing ± 3%	
Top Body – 33.4 ft	
Top Left Corner – 12.5 ft	
Top Left Jib – 3.25 ft	
Top Right Corner – 33.4 ft	
Top Right Jib – 3.25 ft	
Left Wing – 48.5 ft	
Bottom Body – 27.66 ft	
Bottom Left Corner – 16.33 ft	
Bottom Left Jib – 3.25 ft	
Bottom Right Corner – 16.33 ft	
Bottom Right Jib – 3.25 ft	
Intermediate – 8.18 ft	
Codend – 16.31 ft	
B. Hanging Cable ± 2%	
Diameter – 0.625 in	
Headrope – 53.91 ft	
Footrope – 62.2 ft	
Leglines – 6 ft	
Wingline diameter – 3/8 in	
Wingline length – 71.5 in	
C. Footrope Weight ± 2%	
Chain size – ¼ in	
Chain length – 67.8 ft	
Total chain weight – 48 lbs	
Number of loops – 50	
D. Mud Rollers ± 2%	
Size – 6 in x 8 in	
Number – 16	
Spacing – 3 ft	
Clearance from footrope – 3 in	

E. Flotation ± 5%

Size – 3 in x 4 in	
Number – 6	
Spacing 5 ft	

F. Lazyline ± 3%

Size – 0.75 in	
Length – 108 ft	

G. Net Treatment ± 0%

Type – Plastic coat	
Color - green	

H. Doors ± 2%

Door type – rectangular flat wooden	
Length – 8ft	
Height – 40 in	
Chain size – 0.5 in	
Chain type – G4 galvanized	
Top front chain – 29.25 in	
Bottom front chain – 27.5 in	
Top back chain – 57 in	
Bottom back chain – 55 in	
Swivels – 5/8 in galvanized	
Bolts – 5/16 in cadmium plated	
Planking – 5/4 in grade 1 pine	
Stiffeners – 4 in x 4 in pine	
Uprights – 2 in x 10 in pine	
Door shoe – 1 in x 6 in flat stock	
Door bridle – 23.5 in (tow point to door face	
Weight – 450 lbs	

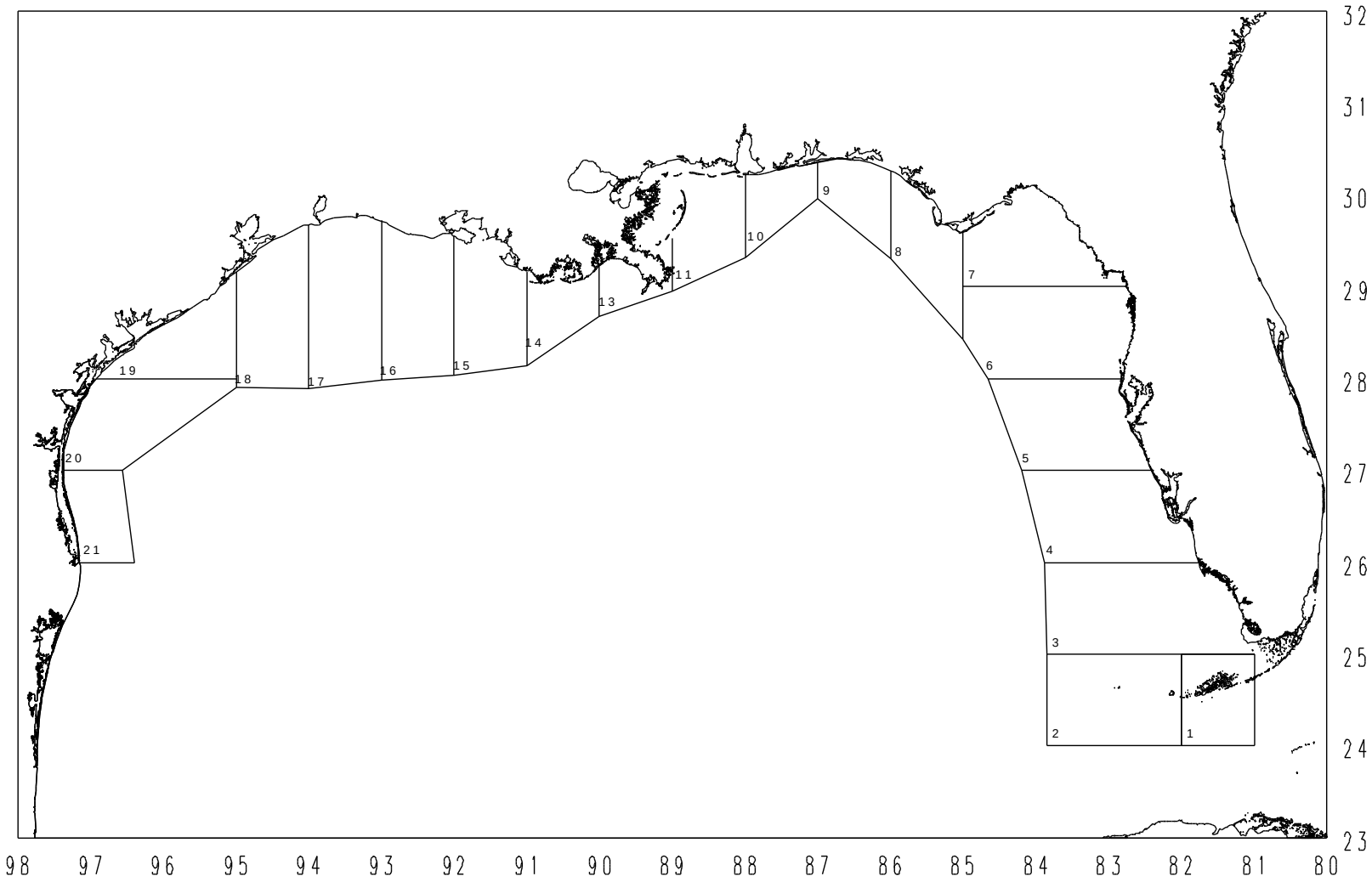
I. Tickler chain ± 2%

Size – 0.25 in standard link	
Length – 58.7 ft	
Weight – 41.6 lbs	

J. Bridles ± 2%

Wire type – 6 x 19 IWRC galvanized wire rope	
Wire diameter – 0.5 in	
Length – 180 ft	

Survey area



Southeast Fisheries Science Center Shrimp/Bottomfish survey area including shrimp statistical reporting zones (offshore boundaries follow the 60-fm isobath).